XI. *Several* Eſſays *towards diſcovering the* Laws *of* Electricity, *communicated to the* Royal Society *by Mr.* John Ellicott *F.R.S. and read on the* 25*th of* Feb. 1747. *and at two Meetings ſoon after.*

1. *A Letter to* Martin Folkes *Eſq; Pr. R. S.*

S I R,

Read Feb. 25. 1747-8.

IN the * Letter lately read before the *Royal Society* from the Abbè *Nolet*, containing his Obſervations on the Increaſe of the Tranſpiration of Animals, and the Growth of Vegetables, by means of the electrical *Effluvia*, he takes notice, that he was led to thoſe Inquiries, from the Acceleration which (he found from a great Number of Experiments) was given to the Motion of Fluids thro' capillary Tubes, upon their being electrified. As I formerly made ſeveral Experiments on this Subject, I ſhall ſubmit it to your Conſideration, whether the following Obſervations on thoſe Experiments may deſerve the Notice of this illuſtrious *Society*. In which I have principally endeavoured to prove, that the Acceleration of the Motion of Fluids thro' capillary Tubes or Syphons is not barely owing to their being electrified, but that, in all Caſes whatſoever, there are ſome other Circumſtances neceſſary, in order to produce this Effect. And I doubt not but to make this fully appear, by ſhewing, that Water, being electrified, may either be made to run in

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* See the preceding Paper, *Art.* X. *p.* 187.

in a conſtant Stream thro' a capillary Tube or Siphon, or only to drop, as if it had not been electrified at all: And likewiſe, that the Water may be made to run from the ſame Syphon in a conſtant Stream, without being made electrical, but ceaſe to run, and only drop, the Moment it becomes electrical. Under the one or other of theſe Caſes, I ſhall have an Opportunity of taking notice of the ſeveral Varieties obſervable in theſe Experiments; all of which I ſhall endeavour to account for from the following general Principles.

First, That the ſeveral electrical *Phænomena* are produced by means of *Effluvia*.

Secondly, That the Particles compoſing theſe *Effluvia* ſtrongly repel each other.

Thirdly, That the ſaid Particles are ſtrongly attracted by moſt if not all other Bodies whatſoever.

That the electrical *Phænomena* are produced by means of *Effluvia*, is in general acknowledged by all the Authors who have wrote upon Electricity, however they may differ in Opinion with regard to the Bodies in which they are contained. The Properties I have mention'd of theſe *Effluvia* may be eaſily deduced from moſt of the Treatiſes lately publiſhed on this Subject. But to leave no Room for any Objection, I would beg Leave to obſerve, that the Exiſtence of theſe *Effluvia* is proved by all thoſe Experiments in which a Stream of Light is ſeen to iſſue from the electrified Body; particularly thoſe Streams which are ſeen to iſſue in diverging Rays from the End of the original Conductor, when made of Metal, and reduced to a Point; from their being felt to ſtrike againſt the Hand like a Blaſt of Wind, when it is brought near the Stream, and from that offenſive Smell which generally accompanies theſe Experiments, and which is always more perceptible, the more ſtrongly the Sphere is excited.

That the Particles compoſing theſe *Effluvia* repel each other, appears from thoſe Experiments, in which two Bodies, how different ſoever they may be in kind, repel each other when they are ſufficiently impregnated with theſe *Effluvia*. As a Feather, by the excited Tube; the ſeveral Fibres of the ſame Feather, or two Cork Balls, which will be found ſtrongly to repel each other, ſo long as they retain any conſiderable Quantity of theſe *Effluvia*. Which Property will always decreaſe, as the Quantity they contain diminiſhes.

That theſe *Effluvia* are ſtrongly attracted by moſt if not all other Bodies, is ſo evident from almoſt all the electrical Experiments, as to make any particular Examples of it needleſs here; eſpecially as I ſhall have Occaſion to take notice of the ſtrong Attraction between the electrical *Effluvia* and Water, in accounting for theſe Experiments. And the firſt, I would take notice of, I ſhall now proceed to ſtate as follows.

EXPERIMENT I.

If a Veſſel of Water is hung to the prime Conductor, having a Syphon in it of ſo ſmall a Bore that the Water will be diſcharged from it only in Drops, on the Water's becoming electrical by means of the Machine, it will immediately run in a Stream, and continue to do ſo, till the Water is all diſcharged, provided the Sphere is continued in Motion.

That Water does not run in a conſtant Stream, but only in Drops, from a Syphon of a ſmall Bore, is doubtleſs owing to the ſame Cauſe by which it is ſuſtained above the Level in capillary Tubes. If therefore Water is made to run in a Stream barely by its being impregnated with the electrical *Effluvia*, it ſhould follow, that if one or more capillary Tubes be placed in a Veſſel of Water, that which is ſuſtained in them would either ſink down to a Level with the reſt of the Water, on its being made electrical, or at leaſt that it would not continue at the ſame Height as before; but if the Experiment is made, the Water will be found to continue exactly at the ſame Height, whether it is electrified or not.

Again, if the bare electrifying the Water was the Cauſe of its running in a Stream, it would continue to run in the ſame manner, ſo long as the Water continued electrical, which it will not do: For, on ſtopping the Motion of the Machine, the Stream will immediately ceaſe, and the Water will only drop from the Syphon, notwithſtanding its being ſtrongly impregnated with the electrical *Effluvia*. To account then for the Water's being made to run in a Stream in this Experiment, I would obſerve, that ſo long as the Machine is in Motion, there is a conſtant Succeſſion of the electric *Effluvia* excited, and which viſibly run off from the End of the prime Conductor in a Stream, and as they are in like manner carried off from all Bodies hung to it, thoſe *Effluvia* which run off from the End of the Syphon, being ſtrongly attracted by the Water, carry ſo much of it along with them, as to make it run in a conſtant Stream.

That the Attraction between the Water and electric *Effluvia* is ſufficient to produce this Effect, might be proved by a Variety of Experiments; but I ſhall only obſerve, that to this Attraction it is owing that ſilk Lines and glaſs Tubes (which, from their imbibing ſo very ſmall a Quantity of theſe *Effluvia*, are generally made uſe of as Supports in many of the electrical Experiments) on only being wetted become ſtrong Conductors: And that if an excited Tube is held over a Veſſel of Water, the Water is found to imbibe a very conſiderable Quantity of this electric Matter; and, on the Approach of a Finger, or any other non-electric Body, the Water will be perceived to riſe towards it; and if the Finger is brought ſo near the Surface as to draw off the *Effluvia*, they will carry ſeveral Particles of the Water along with them towards the Finger, in a Direction directly contrary to that of Gravity; and therefore may well be ſuppoſed, when acting in the ſame Direction, to have an Influence ſufficient to produce a Stream, as in the Experiment.

And that this Current of the electric *Effluvia* is the true Cauſe why the Water runs in a Stream from the End of the Syphon, is farther evident, in that whatever tends to increaſe or diminiſh the Current of the *Effluvia*, produces the ſame Effect upon the Water. I have already obſerved, that when the *Effluvia* are ſtrongly excited, they will be ſeen to paſs off from the End of the prime Conductor in luminous Rays; and the ſame may be obſerved with reſpect to thoſe which paſs with the

Water from the End of the Syphon; but if any non-electric Body is brought under the Syphon, as, by its Attraction, the Current of the *Effluvia* will be increaſed, ſo theſe luminous Rays will likewiſe extend to a greater Length. Again, if the Motion of the Machine is ſtopped, the Current of the electric *Effluvia* will thereby be ſtopped, and the Water will immediately ceaſe to run in a Stream, notwithſtanding its being ſtrongly impregnated with the electrical *Effluvia*.

And that the Water is ſtrongly impregnated will not only appear from the Drops being ſooner divided into ſmall Particles than they would be if they had not been electrified, but from thoſe Particles being ſeparated to a greater Diſtance from each other, by the repulſive Property of the electric *Effluvia*; and if any of the Water is received into a dry glaſs Veſſel, on the Approach of a Finger towards its Surface, there will be ſeen a Spark to iſſue from it in the ſame manner as from Water electrified by an excited Tube; or if any non-electrical Body is brought under the Syphon, by whoſe Attraction the *Effluvia* may be drawn off, the Water will immediately be found to accompany it in a Stream.

Exp. II.

If the Veſſel of Water with the Syphon in it is ſuſpended by any non-electric Body over another ſtrongly electrified, the Water will immediately run from the Syphon in a Stream; but if ſupported by a Piece of Silk, or any other electrical Body, the Water will immediately ceaſe running, and only be diſcharged in Drops. Theſe *Phænomena* may, from what has been already ſaid under the former Experiment, be eaſily accounted for.

That the Water is made to run in a Stream, is plainly owing to the mutual Attraction between the electriſed Body and the Water; which Attraction will continue, ſo long as the Veſſel which contains the Water, by being ſupported by a Non-electric, is prevented from retaining any of the electrical *Effluvia*; theſe *Effluvia* being drawn off by the non-electric Body, to which the Veſſel is ſuſpended: But on the contrary, when the Veſſel is ſuſpended by an Original Electric, the *Effluvia*, not being attracted thereby, will be prevented from running off, and the Water will ſoon be found to have imbibed a Quantity of them, ſufficient, by their repelling Property, to greatly weaken, or wholly to deſtroy, the former Attraction, when the Water will ceaſe to run in a Stream, and only drop, as if it had not been held near any electriſed Body. Monſ. *L'Abbe Nolet* has endeavoured to account for the former Part of this Experiment, by ſuppoſing there is, what he calls, both an affluent and an effluent electric Matter; but he takes no notice of the latter Part, which is not eaſily ſolved upon his Suppoſition. But if what I have obſerved on theſe Experiments is ſatisfactory, I apprehend I have accounted for the ſeveral *Phænomena* on much more ſolid Principles, and that thereby any leſs certain Hypotheſis is render'd uſeleſs.

I intended to have taken ſome notice of the different Acceleration of the Fluids thro' Tubes of different Bores; but as this Acceleration will always vary with the Current of the electrical *Effluvia*, unleſs ſome Method could be found out to render this Current uniform throughout the whole Series of Experiments, the Proſecution of this Inquiry will be rendered extremely difficult, and the Reſult will at beſt be very uncertain. I am Sir, with the greateſt Reſpect,

Your moſt obedient humble Servant,

John Ellicott.

When the foregoing curious Letter was read at the Meeting of the *Royal Society* on *Thurſday* the 25th of *February* laſt, 1747. I acquainted the Gentlemen preſent, that the ſame ingenious Author had communicated to me a Paper ſeveral Months before, in which he had more fully and particularly delivered his Thoughts on the ſurprizing *Phænomena* of Electricity, and as ſeveral Perſons expreſſed their Deſire of ſeeing that Paper, I requeſted of him either a Copy, or an Abſtract of the ſame; in Compliance with which he, ſome Days after, gave me the two following Papers, containing the Subſtance of what he had before ſhewn me; and I immediately put them into the Hands of Dr. *Mortimer*, one of the Secretaries of the *Society*, who read them at the two Meetings of the *Society*, on the ſeveral Days noted at the Head of thoſe Papers.

M. Folkes.

2. *An* Eſſay *towards diſcovering the* Laws *of* Electricity, *addreſſed to the* Royal Society.

Read March 24. 1747-8.

THE great Difference I obſerved in the Sentiments of thoſe ingenious Gentlemen who have favoured us with their Diſcoveries in Electricity, made me very deſirous of finding out ſome general Principles, by means of which I might be able to form a Judgment of the ſeveral Hypotheſes whereby they have endeavoured to account for the principal *Phænomena* obſervable in thoſe Experiments. In order to this I took a general Survey of all the more remarkable Experiments, and out of them made Choice of ſuch as I judged were moſt proper for my Purpoſe; and from theſe I deduced the general Principles hereafter mentioned. The Advantage I promiſed myſelf from this Method was, that the plainer and more ſimple the Experiments were, which I made choice of, the leſs liable I ſhould be to miſtake in any Concluſions drawn from them; and that every freſh Experiment, I could account for by them, would be an additional Proof in their Favour; and if my Attempt in explaining the following Experiments from thoſe Principles ſhould prove ſatisfactory, the Truth of them would be thereby ſo fully confirmed, that we might ſafely rely on them in forming a Judgment of any of the Diſcoveries already made; and (how general ſoever they may ſeem to be) I doubt not but they will be found of Service in proſecuting our future Inquiries on this Subject.

The Experiments from which I deduced theſe Principles were theſe which follow.

EXPERIMENT I.

If a glaſs Tube is rubbed by a very dry Hand, and a Finger is brought near any Part of it, a Spark of Fire will ſeem to iſſue from it, and ſtrike againſt the Finger; and if the Finger is carried at a like Diſtance from the End of the Tube towards the Hand in which it is held, a Number of Sparks at a ſmall Diſtance from each other will be ſeen coming from it, and a ſnapping Noiſe will be heard. The Tube is then ſaid to be excited, or to be electrical; and at ſome times, when it is ſtrongly excited, Sparks will iſſue from the Tube in Streams, not only while it is rubbing, but will continue to dart out from it for a conſiderable time after the Rubbing has ceaſed, and a very ſtrong offenſive Smell will be perceived.

EXP. II.

If the Tube, when thus excited, is held over ſome Pieces of Leaf-Gold, or any light Bodies whatſoever, they will be attracted towards it; and the more ſtrongly the Tube is excited, the greater Diſtance they will be attracted from; and when they come near the Tube (tho' without touching it) they will be repelled from it, and continue to be ſo, unleſs touched by ſome other Body, when they will be attracted by the Tube as before: But if the Tube is but weakly excited, they will be attracted quite to the Tube, to which they will ſometimes adhere, without being repell'd from it.

Exp. III.

If a Ball (of Cork ſuppoſe for Lightneſs) be hung by a ſilk Line, and the excited Tube is applied to it, it will not only be attracted, but will have an attractive Quality communicated to it from the Tube; and if any light Bodies are brought near the Ball, they will be attracted by it.

Exp. IV.

As the Tube, when ſtrongly excited, will not only attract, but afterwards repel any light Bodies brought near it, in like manner the Cork-Ball will be endued with the ſame Property; ſo that a ſmaller Ball will firſt be attracted towards it, and then repelled from it, the ſame as the Leaf-Gold in *Exp.* 2. and on touching any other Body it will be again attracted; and this may be repeated ſeveral times, provided the ſmaller Ball is much leſs than the larger one, tho' the Effect will conſtantly grow weaker and weaker, as every time the leſſer Ball is attracted, it carries off with it ſome of the electric Virtue, and is likewiſe endued with the ſame Properties as the larger Ball.

Mr. *Gray*, Mr. *Dufay*, and others have obſerved, that this electrical Quality is not only to be excited in Glaſs, but in moſt ſolid Bodies capable of Friction (Metals excepted); tho' in ſome it will be ſcarcely ſenſible, and that it is found to be ſtrongeſt in Wax, Reſins, Gums, and Glaſs: And as Glaſs is the eaſieſt procured of a proper Form, it has generally been uſed in making theſe Experiments. It has been further obſerved, that thoſe Bodies in which the electrical Quality is capable of being excited the ſtrongeſt by Friction will receive the leaſt Quantity of it from any other excited Body, and therefore are properly made uſe of to ſupport any Body deſign'd to receive the electrical Virtue. The Truth of this will ſufficiently appear from the following Experiment.

Exp. V.

Hang up two Lines, one of Silk, and the other of Thread; that of Thread will be attracted by the Tube at a much greater Diſtance than the Silk. Again; Faſten to each String a Feather, or other light Body; if the Tube is brought to the Feather faſtened to the Silk, it will be firſt attracted, and afterwards repelled; and from the Virtue communicated to it from the Tube, the ſeveral Fibres of the Feather will ſtrongly repel each other. But when the Tube is brought to the Feather faſtened to the Thread, the Feather will be ſtrongly attracted, and continue to be ſo, without ever being repell'd, the Virtue paſſing off by the Thread it is hung to. If a glaſs Ball is hung to the ſilk Line, it will be but weakly attracted by the Tube; but one of Cork or Metal much ſtronger.

Exp. VI.

Let a Rod of Iron be ſuſtained by ſilk Lines, and by means of a glaſs Sphere (which can be more regularly and conſtantly excited than a Tube) be made electrical; it will be found to have all the Properties of the excited Tube mention'd in *Exp.* 1. A

Stream of Light will come from the End of it, if it is pointed; it will attract, repel, and communicate this Virtue to any other non electric Body: On the Approach of a Non-electric, a Spark of Fire, with a Snap attending it, will come from it; which Spark will be greater or leſs, as the Bodies approaching it have more or leſs of the electrical Quality reſiding in them; and there will likewiſe be the ſame offenſive Smell as was obſerved of the Tube.

From theſe Experiments, which I think contain the principal *Phænomena* of Electricity, may juſtly be drawn the following Concluſions:

1*ſt*. That theſe remarkable *Phænomena* are produced by means of *Effluvia*; which, in exciting the electrical Body, are put into Motion, and ſeparated from it.

2*dly*. That the Particles compoſing theſe *Effluvia* ſtrongly repel each other.

3*dly*. That there is a mutual Attraction between theſe Particles, and all other Bodies whatſoever.

That there are *Effluvia* emitted from the Tube when rubbed, and which ſurround it as an Atmoſphere, is evident, from that offenſive Smell ariſing from them, from that Senſation on the Hands or Face, when the Tube is brought near either of them, and from thoſe Sparks of Light, on a ſtill nearer Approach of the Finger to it.

That the Particles of theſe *Effluvia* repel each other, is proved by the Cork-Balls (*Exp.* 4.) and the Fibres of the Feather (*Exp.* 5.) repelling each other, when impregnated with them; and by the Leaf-Gold (in *Exp.* 2.) being repelled by the Tube, and not returning to it again, until, by coming near, or touching, ſome non-electric Body, the *Effluvia* are drawn off from it.

From this Property it is, that theſe *Effluvia* expand themſelves with ſo great a Velocity whenever they are ſeparated from the electric Body; and as they are likewiſe capable of being greatly condenſed, may we not from hence juſtly conclude they are elaſtic?

That there is a mutual Attraction between theſe *Effluvia* and moſt other Bodies, appears from their collecting from the Tube ſuch Quantities thereof, as to endue them with the ſame Properties with the Tube itſelf, as was proved by the 3*d*, 4*th*, and 5*th* but more particularly by the *6th Experiment*.

Theſe Principles being admitted, it will follow, that the greater Difference there is in the Quantity of electrical *Effluvia* in any two Bodies, the ſtronger will be their Attraction. For, if the *Effluvia* in each are equal, inſtead of attracting, they will repel each other; and in proportion as the Quantity of electric Matter is drawn from one of the Bodies, will the Attraction between them increaſe, and conſequently be ſtrongeſt, when any one of them has all the electrical Matter drawn from it.

The Particles of theſe *Effluvia* are ſo exceedihg ſmall, as eaſily to pervade the Pores of Glaſs, as is evident, in that a Feather, or any light Bodies incloſed in a glaſs Ball hermetically ſealed, will be put in Motion on the excited Tube being brought near the Outſide of it; and it has been generally thought that they paſs through the Pores of the denſeſt Bodies; and there are ſeveral Experiments which render this Suppoſition not improbable; tho' I muſt acknowledge I have not yet met with any one that I think is quite concluſive.

I ſhall now proceed to ſhew, how, from theſe Principles, the *Phænomena* of ſome of the more remarkable Experiments of Electricity may be accounted for.

Exp. VII.

Let a Rod of Iron, pointed at one End, be ſuſpended on ſilk Lines, as in *Exp.* the *6th,* and by the Sphere be made electrical. When the Rod is ſtrongly electrified, a Stream of Light in diverging Rays will be ſeen to iſſue from its Point; and if any non-electric Body is held a few Inches from the Point, the Light will become viſible to a greater Diſtance, and if the non-electric Body is likewiſe pointed, a Light will ſeem to iſſue from that in diverging Rays in the ſame manner as from the electrified Rod. But if the non electrical Body is flat, and held at the ſame Diſtance from the Rod as the pointed one was, no Light will be ſeen to come from it.

The principal *Phænomena* to be accounted for in this Experiment are; Why a Light is only ſeen at the Point of the Rod, and not through the whole Length of it? Why this Light is viſible to a greater Length, when the Point is approached by a Non-electric? And, Why a Light is ſeen to iſſue from the Non-electric when it is pointed, and not when it is flat.

Upon which I obſerve, that whenever the Sphere is excited, the electrical *Effluvia* are thereby put into Motion, and made to form an Atmoſphere

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round about it, from whence, by their repulſive Property, they endeavour to expand themſelves on all Sides equally; but being ſtrongly attracted by the Iron, a great Part of them are drawn off along the Rod, about whoſe Surface they likewiſe form an Atmoſphere, which will be denſer or rarer, in proportion as the Attraction of the Rod is greater or leſs; and as the repulſive Power of theſe *Effluvia* will always increaſe in proportion with their Denſity, it will follow, that whenever the Sphere is ſo ſtrongly excited, that the *Effluvia* ſurrounding it are denſer than thoſe ſurrounding the Rod, they will, by their repulſive Property, drive the *Effluvia* off from the End of it in a Stream, and that with a very great Velocity; as is evident, from their ſtrikeing againſt the Hand like a Blaſt of Wind when brought near the End of the Rod: And as this Velocity is partly owing to the Attraction of the Rod, ſo this Attraction continuing quite to the End of it, the Velocity of the Particles will there be greateſt; and as they approach towards the Point, they will be brought nearer together, and therefore become denſer there than in any other Part of the Rod; and therefore if the Light is owing to the Denſity and Velocity of the *Effluvia*, it will be viſible at the Point, and no-where elſe.

And that the Light is thus produced, will appear, in that whatever increaſes or diminiſhes either the Velocity or Denſity of the Particles will increaſe or diminiſh the Light. For, let the Motion of the Wheel which turns the Sphere be ſtopped, the Current of the *Effluvia* will likewiſe be ſtopped, and the Rays of Light will no longer be ſeen to iſſue from the

Point, and yet the whole Rod will continue to be electrical; but, on putting the Sphere again into Motion, the *Effluvia* will become viſible as before, and will increaſe, as the Sphere is more ſtrongly excited. Again, the Light will be viſible to a greater or leſs Diſtance, as the Point is more or leſs acute; and as this Light is always brighteſt next the Point, and grows fainter, as the Rays diverge, this is plainly owing to the different Denſity of the Rays at equal Diſtances; for, when the Point is more acute, the Rays will diverge leſs, and therefore will be denſer to a greater Diſtance than when it is leſs acute.

When a Non electric, whoſe End is flat, is brought within a few Inches of the Point of the electrified Rod, the electric Stream will be attracted by it, and the Rays made to diverge leſs than before; and the Effect will be the ſame as if the Point was more acute; *viz.* a Continuation of the Light to a greater Diſtance, and which will be farther increaſed by the additional Velocity the Particles will acquire from the Attraction of the Non-electric. What will follow on a nearer Approach of the Non-electric to the Rod, will be conſider'd under the next Experiment.

If the Non-electric is pointed, and held in the ſame Place as the former, a Light will appear from it the ſame as from the electrical Body: For, as the Points of the two Rods are the Parts which approach neareſt each other, the Attraction there will be ſtrongeſt: The Rays therefore, which diverged from the electrical Rod, will be attracted by, and made to converge towards, the Point of the non-electrical Rod, and will conſequently be nearly of the ſame Denſity at the one as the other; and the

Velocity being accelerated by the additional Attraction, the Rays will become luminous at the Point of the Non-electric, the ſame as at the Point of the electrified Rod. If this Experiment is made with a Tube, inſtead of a Sphere, as it cannot be ſo uniformly excited as the Sphere, the Light will iſſue from the Rod in Flaſhes, as the Tube is more or leſs excited.

Several very ingenious Gentlemen, and in particular the Abbé *Nollet* have imagined, that the Light ſeen at the Point of the Non-electric was produced by means of *Effluvia* iſſuing from it in diverging Rays towards the electrified Rod, and which Current of *Effluvia* is therefore ſuppoſed to be the Cauſe of the attractive, as a like Current iſſuing at the ſame time from the electrified Rod is ſuppoſed to be the Cauſe of the repulſive Property of Electricity.

This Conjecture being directly contrary to the Account I have given of this *Phænomenon*, I ſhall offer ſome Conſiderations in Support of what I have advanced, and which I think will make it appear highly improbable, that any ſuch Current of *Effluvia* iſſues out of the Non-electric; but as what I have to offer on this Subject would treſpaſs too much on the *Society*'s Time at preſent, I ſhall defer it to my next Paper. I am,

Gentlemen,

Your obliged humble Servant,

John Ellicott.

3. *A Continuation of the foregoing* Eſſay.

Read May 19 1748.

IN a Paper I had the Honour to communicate to this *Society*, *March* 24, I endeavour'd, from the Principles therein laid down, to account for ſome of the moſt remarkable *Phænomena* of Electricity; and in particular for that Appearance of a Light iſſuing from the End of an iron Rod, when pointed, and made electrical; Why this Light was viſible only at the Point, and in no other Part of the Rod: Why the Light was viſible to a greater Length when the Point was approached by a Non electric: And why a Light will be ſeen as iſſuing from the Non-electric when it is pointed, but not when it is flat.

I ſhall now endeavour, from the ſame Principles, to account for thoſe *Phænomena*, which will be produced on a nearer Approach of the Non-electric to the electrified Rod.

Exp. VIII.

If the non-electric Body, whether flat or pointed, is brought nearer to the End of the Rod, than in the laſt Experiment, there will be a ſmall Stream of Light produced, reaching quite from the electric to the non-electric Body; and if brought ſtill nearer, there will iſſue a Spark attended with a ſmall ſnapping Noiſe, which will be ſucceeded by others at equal Intervals; and if the Non-electric is held at ſome Diſtance from the Side of the Rod, the Point of it will frequently appear luminous, but no Part of the electrified Rod will be ſo. If it is brought nearer, there will likewiſe be Sparks produced at nearly equal Intervals from each other, which will ſometimes appear as iſſuing from the Side of the electrified Rod, at others, as coming from the Non-electric.

If a Finger is uſed as the Non-electric, it will receive a ſmart Stroke; and if Spirit of Wine, heated ſo as to emit an inflammable Vapour, is made uſe of, it will be kindled by the Spark.

These *Phænomena* may, on the afore-mention'd Principles, be thus accounted for.

If the non-electric Rod is pointed, and brought ſo near, as, by its Attraction, to prevent the Rays iſſuing from the Point of the electrified Rod from diverging, they will be drawn off parallel to each other, and conſequently be equally luminous throughout the whole Diſtance between the two Rods.

If the Non-electric be brought ſtill nearer, the attractive Force will be ſo much increaſed, as not only to affect the *Effluvia*, when they are driven off from the Point of the electrified Rod, but to be capable of drawing them off from a conſiderable Part of the Rod beyond the Point; and that with a Velocity, and in a Quantity, ſufficient to occaſion both the Spark and Blow, as well as the Noiſe that is heard.

The ſame is the Caſe, when the non-electric Rod, or a Finger, is held againſt the Side of that which is made electrical: At a greater Diſtance a Light will appear as iſſuing from the Non-electric, the Particles attracted from a large Surface of the Rod (and therefore not viſible as coming from it) being made to converge to a Point, are thereby rendered luminous, and, if brought nearer, there will iſſue Sparks in the ſame manner as when held to the End: And that this is owing to the Increaſe of the attractive Force, ſeems plain; for it was obſerved in the laſt Experiment, the Attraction was capable of changing the Direction of the Rays at the Diſtance of ſeveral Inches; whereas a Snap or Spark is ſeldom produced, when the Non-electric is held more than an Inch and half diſtant. If therefore the Attraction decreaſes, as the Squares of the Diſtances increaſes, as it probably does, the attractive Force will be many times greater in one Caſe than in the other, and if where the attractive Power was weaker, as in the former Experiment, there were ſo many Rays of the electric Matter collected, as to be ſufficient to produce a Light, it cannot be thought extraordinary, when the Attraction is ſo greatly increaſed on the nearer Approach of the Non-electric, that both the Denſity and Velocity of the Particles ſhould be thereby increaſed, ſo as to produce Heat ſufficient to fire the Vapour ariſing from Spirit of Wine, or any other inflammable Vapour.

And that the Quantity of the electric Particles is greatly increaſed, as well as their Velocity, is evident from that large Surface of the Rod, which, by the Approach of a Finger, is in one Spark diveſted of them; and which requiring ſome time before it can be again ſufficiently recruited, I apprehend is the Reaſon of that Interval between the Sparks. And here it muſt be obſerved, that the Diſtance the Point of the Non-electric is held at from the Rod, in order to produce the greateſt Spark, muſt be varied, in proportion as the Rod is electrified in a greater or leſs Degree; the more ſtrongly the Rod is impregnated the greater will be the Diſtance; and if then the Non-electric is brought nearer, the Sparks will be ſmaller, but ſucceed each other quicker; ſo that when it is brought almoſt to touch the Rod, they will appear like a ſmall Stream. The Reaſon of which I take to be, that as the electric Atmoſphere ſurrounding the Rod is denſer nearer it than farther off, when the Non-electric is brought into ſo very denſe a Part of the Atmoſphere, it will from thence become nearly as electrical as the Rod itſelf; and therefore loſe great Part of its attractive Force, and conſequently will only be able to draw off thoſe Particles from the Rod which are neareſt to it.

I would farther take notice, that the Sparks are always produced in the Space between the Non-electric and the Rod, and often appear as iſſuing from the Non electric. This Appearance is probably owing to thoſe Particles, which, by their Elaſticity, are reflected back again from the Non-electric towards the Rod, and which, by ſtriking againſt thoſe coming from it, produce both the Sparks and Noiſe that is heard; and as I have already ſhewn, that the Particles often appear in luminous Rays at the Point of the Non-electric, it thence happens, that the Spark is frequently kindled ſo near to the Non,electric, as to appear as iſſuing from it.

I obſerved, in my former Paper, that ſeveral ingenious Gentlemen, from this Appearance of a Light at the Point of the Non-electric, have imagined there was a Current of electrical *Effluvia* continually iſſuing out of it, and which, ſetting in towards the electrified Rod, was the Cauſe of the Attraction of the Electricity: And this Conjecture of theirs will ſeem to be greatly favoured by the following Experiment.

If ſome of the Fibres of a Down-Feather be faſtened to the End of a ſmall Skewer or Wire, and made electrical, they will ſtrongly repel each other, and will expand themſelves on all Sides to the greateſt Diſtance poſſible from each other; but if a non electric Perſon bring the Point of a Pair of Compaſſes, or any other ſmall-pointed Body near them, they will be repell'd from it, and driven up together as with a Blaſt of Wind, and, in the dark, a Light will be ſeen as iſſuing from the Point; from whence it might be concluded, that the Fibres are repell'd by *Effluvia* iſſuing out of the Point of the Non-electric.

As the Abbé *Nollet* endeavours to account for the Attraction of Electricity on this Principle, I ſhall offer ſome Conſiderations, which, notwithſtanding theſe Appearances, have induced me to be of a different Opinion; and they are founded on the following Obſervations.

Firſt, That however replete any Bodies may be with the electric Matter, none of theſe *Phænomena* are ever produced, unleſs the *Effluvia* are firſt excited in ſome particular Body, and put in Motion, either by rubbing, or ſome ſuch-like Operation.

Secondly, That the *Effluvia* are not to be equally excited in all Bodies, but much ſtronger in ſome than in others; and that, in particular, they are not capable of being at all excited in Metals by Friction.

Thirdly, The attractive and repulſive Property will be ſtronger or weaker in any Body, in proportion to the Quantity of excited *Effluvia* wherewith it is impregnated.

Fourthly, That thoſe Bodies which are moſt eaſily excited by Friction, will receive the leaſt Quantity of the electrical *Effluvia* from any other excited Body; and, on the contrary, Metals, or thoſe Bodies in which they cannot be excited by Friction, will receive the moſt.

From theſe Obſervations I think it may be ſhewn, that this Appearance of Light is ſo far from proving that the *Effluvia* come out of the Non-electric, at whoſe Point they are viſible; that from thence it cannot be concluded the Body has any of the electrical Matter reſiding in it, but is rather a Proof to the contrary. For I have already ſhewn, that the ſame Appearance would be produced from the ſetting in of the *Effluvia* into the Non-electric; and this might be confirmed, if neceſſary, by a Variety of Experiments. And as thoſe Bodies, at whoſe Point this Light appears the ſtrongeſt, afford us no Signs of their having any of the electrical *Effluvia* reſiding in them, either by their attracting or repelling other Bodies, or by their being capable of being excited in them by Friction, as in Glaſs, *&c.* nor in ſhort any ſort of Evidence whatſoever, but what ariſes from this Appearance; may we not expect ſome better Proof of their being poſſeſſed of theſe *Effluvia*, before we admit of their iſſuing out of them?

Again, it appears very extraordinary, that thoſe Bodies, in which the *Effluvia* cannot be excited by any other Method, ſhould ſend forth ſuch Streams of them, only on their being brought within a few Inches of the electrified Rod, and that theſe Streams ſhould increaſe as the Rod is more ſtrongly electrified; and yet that few or none of theſe Streams ſhould iſſue from thoſe Bodies in which the *Effluvia* can be excited: And if the firſt-mention'd Bodies are themſelves ſtrongly impregnated, the Streams will diſappear, and they will be ſo far from parting with any of their *Effluvia*, that, on the contrary, they will be ſtrongly repelled by the Rod.

I farther apprehend, on this Suppoſition, it will be extremely difficult, if not impoſſible, to account for the ceaſing of the Stream from the Point of the Non-electric on ſtopping the Machine; as likewiſe that the Rod ſhould ſo ſoon be diveſted of its *Effluvia*, on ſuch a Non-electric's being held near it, which it would otherwiſe retain for ſeveral Hours, and which I think is a ſtrong Proof of the *Effluvia*'s paſſing from the Rod into the Non-electric. And that it certainly does ſo, may be confirmed by the Perſon who holds the Non-electric ſtepping upon a Cake of Wax, when he will ſoon become electrical, from the *Effluvia* he will receive (thro' the Point of the Non-electric) from the Rod; but ſo long as he continues to ſe ſo, there will not be ſeen any Light to iſſue from the Point; which I apprehend cannot be accounted for on any other Principle, but that of the ſetting in of the *Effluvia* at the Point of the Non-electric. And as I have already ſhewn, that all the *Phænomena* are naturally to be accounted for on this Principle, without being liable to any of the above-mention'd Objections, I muſt remain of the Opinion (till I can ſee

theſe

theſe Objections anſwer'd) that this Appearance of Light is no Proof that the *Effluvia* iſſue out of the Non-electric, but of the direct contrary.

The above-mention'd Objections might be brought, with equal Force, againſt the Fibres of the Feather being repelled by *Effluvia* iſſuing out of the Point of the Non-electric that is held near it, and in particular, that this Effect would ceaſe to be produced, either when the Machine was ſtopped, or the Perſon who held the Point became electrical. And to theſe I would add, that if this was really the Caſe, the Fibres would continue to be repell'd, notwithſtanding any Alteration in the Shape of the Non-electric; whereas, on the contrary, if the Joint of a Pair of Compaſſes was held towards them, inſtead of the Point, they would be ſtrongly attracted to it: And the ſame will always happen, whenever an obtuſe Body is brought near them inſtead of a pointed one.

The true Cauſe of this remarkable *Phænomenon* I apprehend to be the different Denſity of the *Effluvia* at the Extremities of the two Bodies; for I have already ſhewn the *Effluvia* will be much denſer at the Extremity of a pointed Body than at an obtuſe one: And as the Force by which the Particles endeavour to expand themſelves, increaſes in proportion to their Denſity, it follows, that the Particles will be reflected back with greater Violence from the pointed Body than the other; and this Force exceeding the attractive Power of that particular Part of the Feather, to which it is directed, the Fibres will be repelled by it; whereas the Force, with which the Particles endeavour to expand themſelves from the obtuſe Body, being leſs than the attractive Power, it follows, that the Fibres of the Feather will continue to be attracted by it.

Exp. IX.

Take two Plates of Metal, very clean and dry, whoſe Surfaces are nearly equal; hang one of them horizontally to the electrified Rod, and bring under it upon the other any thin light Body, as Leaf-Silver, *&c.* when the upper Plate is made electrical, the Silver will be attracted by it; and if the under Plate is held at a proper Diſtance, will be perfectly ſuſpended at right Angles to the Plates, without touching either of them; but if they are either brought nearer together, or carried farther aſunder, the Leaf-Silver will ceaſe to be ſuſpended, and will jump up and down between them. The ſame Effect will be produced, if you reverſe the Experiment, by electrifying the bottom Plate, and ſuſpending the other over it.

If the upper Plate is electrified when the Leaf-Silver is brought near, it will be attracted upwards by it, and thereby become electrical; and ſo long as it continues to be electrical, it will likewiſe be attracted downwards by the non-electrical Plate. Whenever therefore this laſt Attraction added to the Gravity of the Silver, which acts in the ſame Direction, is equal to the contrary Attraction upwards, the Leaf-Silver will, by means of theſe two oppoſite Forces, be kept ſuſpended between the Plates, and will continue to be ſo, as long as the Equality of theſe Forces is preſerved.

I have already ſhewn, that the Attraction between any two Bodies will always be in proportion to the different Quantity of electric *Effluvia* they are poſſeſſed of; the greater that Difference is, the greater will be the Attraction. In order therefore to obtain this equal Attraction at firſt, the Leaf-Silver muſt be imbued with a greater or leſſer Quantity, in proportion as the Plate is more ſtrongly or weakly electrified; but always with a much leſs Quantity than the Plate; and likewiſe the lower Plate will require to be placed at different Diſtances, in proportion to the Quantity of electric Matter the upper Plate is poſſeſſed of. As therefore the Suſpenſion of the Silver depends upon the exact Proportion of Attraction (ariſing from the different Quantities of electric Matter) in the two Plates and Leaf-Silver, it follows, that whatever alters the Quantity contained in any one of them would prevent the Suſpenſion.

It is well known, that, by the Attraction between any two Bodies, the electric *Effluvia* are continually drawn off from that which has the greateſt Quantity of them, till the other being ſufficiently impregnated, the Attraction ceaſes. In order therefore to preſerve theſe Proportions, it is neceſſary, that, as faſt as the non-electric Plate draws off any of the *Effluvia* from the Leaf-Silver, it ſhould part with it again; and ſo, by continuing to be a Non-electric, an equal Degree of Attraction be preſerved; and again, that the Leaf-Silver ſhould receive a freſh Supply from the electrical Plate, equal to what it conſtantly parts with; and the electrical Plate muſt likewiſe receive an equal Supply from the Globe;

and that there is ſuch a conſtant Current of the electrical *Effluvia*, is evident, from thoſe ſmall Streams of Light, viſible at the two Corners of the Silver next the Plates. If therefore the Globe ſhould be ſtopped, or the under Plate by any means become electrical, theſe Proportions would be thereby deſtroy'd, and the Leaf-Silver would ceaſe to be ſuſpended.

That the Leaf-Silver is always nearer to the non-electrical than to the electrified Plate, is owing to its receiving its Supply of *Effluvia* from the Atmoſphere ſurrounding the electrified Plate: For as the Plate is more ſtrongly electrified than the Silver, its Atmoſphere of *Effluvia* will be denſer to a greater Diſtance than that ſurrounding the Leaf-Silver, and therefore can ſupply an equal Quantity at a greater Diſtance than what the lower Plate can receive from the Silver, whoſe Atmoſphere is rarer; and therefore, as the Silver will always be ſuſpended in that Part where the two Currents are equal, without which I have already ſhewn the Proportion would be deſtroy'd, it will conſequently be always nearer to the non-electrical than to the electrified Plate. If the Experiment is reverſed, by electrifying the under Plate, and making the upper one the Non-electric, the only Difference will be, that the Gravity of the Silver muſt then be added to the Attraction of the electrified Plate, and will therefore cauſe the Silver either to be nearer the non-electrical one, or the Plates to be moved a little farther aſunder, or perhaps both.

I ſhall not at preſent preſume to take up any more of the Time of this illuſtrious *Society*; hoping that I have already ſhewn how the principal *Phænomena* of Electricity may be accounted for, upon the few Principles I have laid down; and however in different Experiments the Effects produced may either be varied, or increaſed, I doubt not but they may all be eaſily accounted for from the ſame Principles; as I ſhall willingly attempt to make appear at ſome more convenient Time, ſhould it be thought neceſſary. In the mean time I have the Pleaſure to ſubſcribe myſelf,

Gentlemen,

Your moſt obedient humble Servant,

John Ellicott.

XII. *A brief account of a Roman* Teſſera, *by Mr.* John Ward *F. R. S. & Prof. Rhetor. Greſh.*

Read March 3. 1747.

THE braſs plate, which accompanies this paper, and has been the occaſion of it, was dug up ſome time ſince at Market-ſtreet in Bedfordſhire; which lies in the Roman road called *Watlingſtreet*, about five miles on this ſide Dunſtable; and was brought to the *Society* by their worthy Member, *Samuel Clark* Eſq;.

The